Vertical Distribution of Postlarval Brown, *Penaeus aztecus*, and White, *P. setiferus*, Shrimp During Immigration Through a Tidal Pass[1]

Knowledge of the vertical distribution of postlarval penaeid shrimp as they immigrate through tidal passes is useful in developing accurate and efficient sampling techniques for measuring relative abundance. Vertical distribution of postlarval penaeid shrimp as they immigrate into estuarine areas has been studied in two locations in Texas and one in Florida. Penaeid postlarvae (brown, *Penaeus aztecus*; white, *P. setiferus*; and pink shrimp, *P. duorarum*) were significantly more abundant at the surface than the bottom during the night in Aransas Pass (depth to 14 m), Texas; abundance was similar at the two depths during the day (Copeland and Truitt, 1966). King (in press) stated that postlarval grooved shrimp (brown and pink shrimp) abundance was greatest near the surface and

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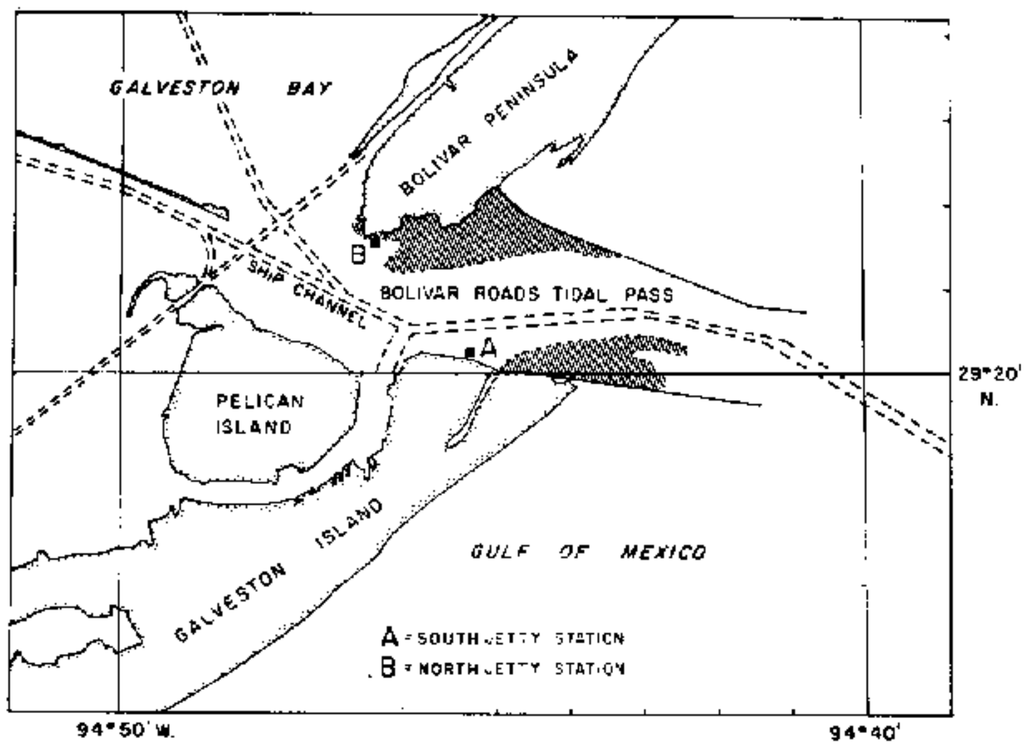

FIGURE 1.—Study area and sampling locations in Bolivar Roads tidal pass, Texas. Shaded areas indicate depths in the tidal pass less than 3 meters.

decreased with depth in Cedar Bayou inlet, Texas. Based on small numbers caught, his data indicated that white shrimp postlarvae were distributed randomly from surface to bottom (maximum depth was 4 m). His data were not analyzed to discern day and night differences in abundance. In 4.5 m of water, pink shrimp postlarvae were about four times more abundant at the surface than the bottom during the day as they entered Tampa Bay, Florida; during the night, however, more postlarvae were caught at the bottom than at the surface (Eldred et al., 1965).

The objective of this study was to determine the vertical distribution of immigrating postlarval brown and white shrimp through a large tidal pass during day and night.

STUDY AREA AND METHODS

Samples were taken at two stations in Bolivar Roads Tidal Pass, the major entrance to Galveston Bay, Texas (Fig. 1). The stations were separated by the 13-m deep Houston Ship Channel. Station A was located in water 4.6 m deep (mean high tide) about 640 m from the channel. Station B was located in water 3.4 m deep about 1,000 m from the channel and was on the bayward end of an extensive shallow sand flat.

The sampling gear consisted of five nets (supported by a channel iron frame) that could be lowered to predetermined depths (Fig. 2). The mouth opening of each net was 30 cm by 55 cm. The nets were of nylon and

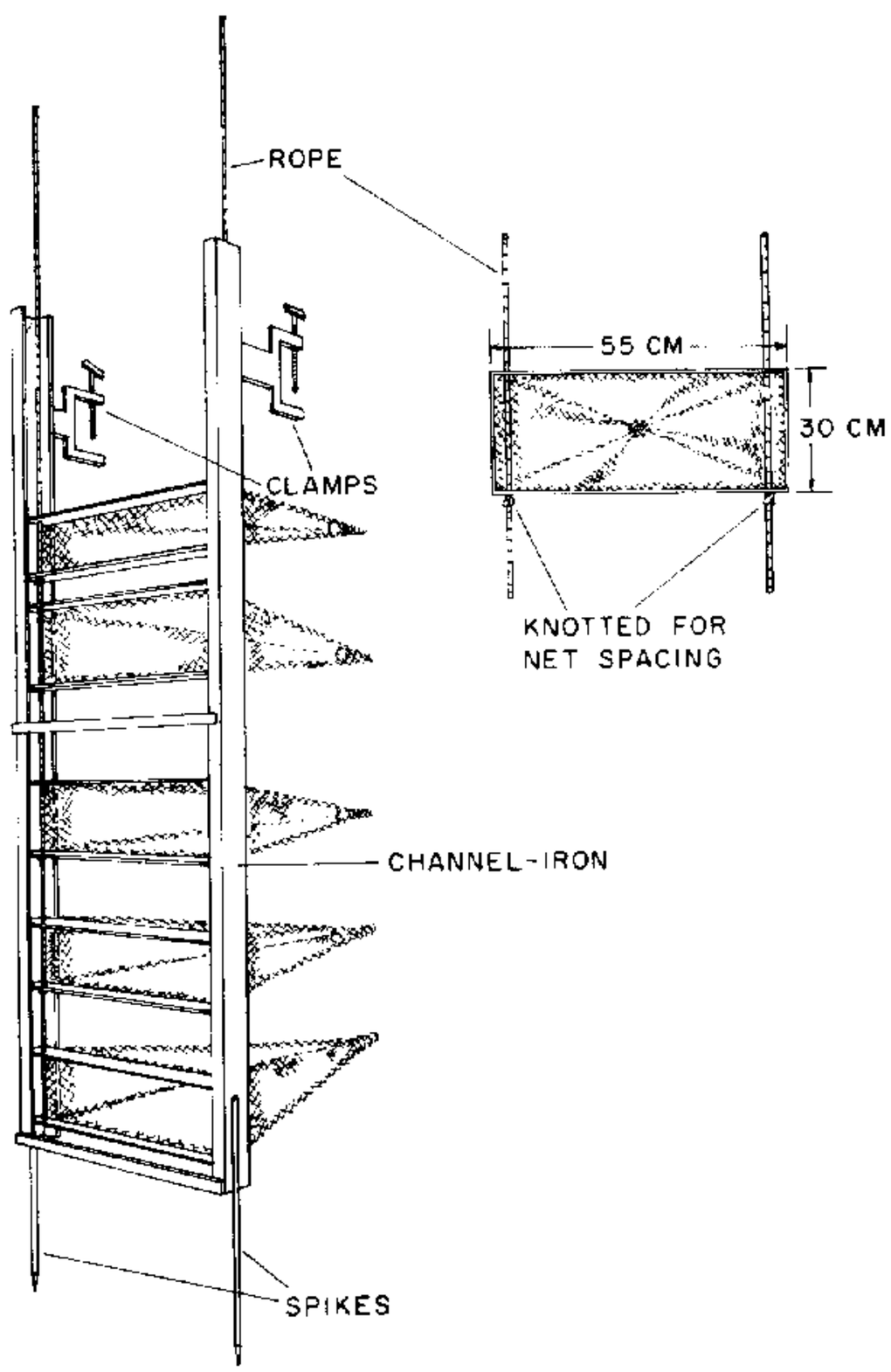

FIGURE 2.—Diagram of the channel-iron frame and nets used to sample postlarvae.

had 50 holes per square centimeter and detachable cups for sample removal. The channel iron frames were attached to U.S. Coast Guard platforms with C-clamps; spikes at the bottom end provided anchorage in the substrate. The five nets were spaced 60 cm apart at station A and 30 cm apart at station B. The bottom net rested on the substrate and the top net was between 0.2 and 0.7 m depending on tidal height) below the surface.

Samples were taken only when flood tide velocities exceeded 0.1 knot (0.05 m/sec) as predicted from the *Tidal Current Tables* published by the Coast and Geodetic Survey. A total of 104 sets of samples (a set of samples consisted of the collections from the five nets fished for 1 hour) were taken on 31 dates from 30 November 1967 through 14 April 1970 (Table 1). The nets were set simultaneously after we determined that there was a bayward flow of water throughout the water

TABLE 1.—*Number of day and night sets taken and the total number of brown and white shrimp postlarvae caught*

Date		Number of sets		Number of shrimp caught	
		Day	Night	Brown	White
1967[1]	11–30	2	0	4	0
	12–12	1	0	6	0
	12–19	1	0	0	0
1968[1]	2–27	1	0	118	0
	3– 1	2	0	560	0
	3– 7	6	0	2,118	0
	3–13	3	0	1,647	0
	3–14	3	0	248	0
	3–20	6	0	1,527	0
	3–26	4	0	139	0
	3–29	1	2	809	0
	4–11	2	0	312	0
	4–18	6	0	799	0
	5–24	1	3	15	201
	6– 4	3	0	1	2
	6– 7	1	2	5	29
	6–25	2	1	250	116
	7–11	3	1	31	286
	7–16	1	0	0	0
	7–30	3	0	0	0
	8– 1	0	5	1,244	51
1969[1]	3–27	4	0	101	0
	5– 6	5	0	163	0
	5–15	3	2	22	68
	7–10	3	3	479	735
	7–30	3	1	5,629	248
1970[2]	3–27	0	1	94	0
	3–30	1	0	873	0
	4– 2	3	0	3,761	0
	4– 7	2	3	6,158	0
	4–15	4	0	1,725	0
Total		80	24	28,838	1,736

[1] Station A.
[2] Station B.

column. After 1 hour, the nets were retrieved, the samples removed, and the nets cleaned and made ready for the next set. Midway through each set the water speed was determined at each sample depth with a current meter. Range and average current velocity by depth and sampling area are shown in Table 2.

The samples were preserved in 10% formalin immediately after being taken and postlarvae were later separated from the sample and identified by characters described by Pearson (1939) and Williams (1959). Total lengths (tip of rostrum to tip of telson) of the postlarvae caught were between 9 and 14 mm for brown shrimp and 5 and 9 mm for white shrimp.

TABLE 2.—*Ranges and averages of current velocities by depth and sampling location*

Station A				Station B			
Depth in meters	Range			Depth in meters	Range		
	Low	High	Mean		Low	High	Mean
	Current velocity—m/sec						
0.8	0.09	0.48	0.30	0.8	0.38	0.94	0.66
1.7	0.10	0.48	0.31	1.4	0.38	0.93	0.65
2.6	0.13	0.46	0.30	2.0	0.31	0.88	0.61
3.5	0.09	0.51	0.30	2.6	0.29	0.81	0.59
4.4	0.09	0.48	0.25	3.2	0.27	0.71	0.54

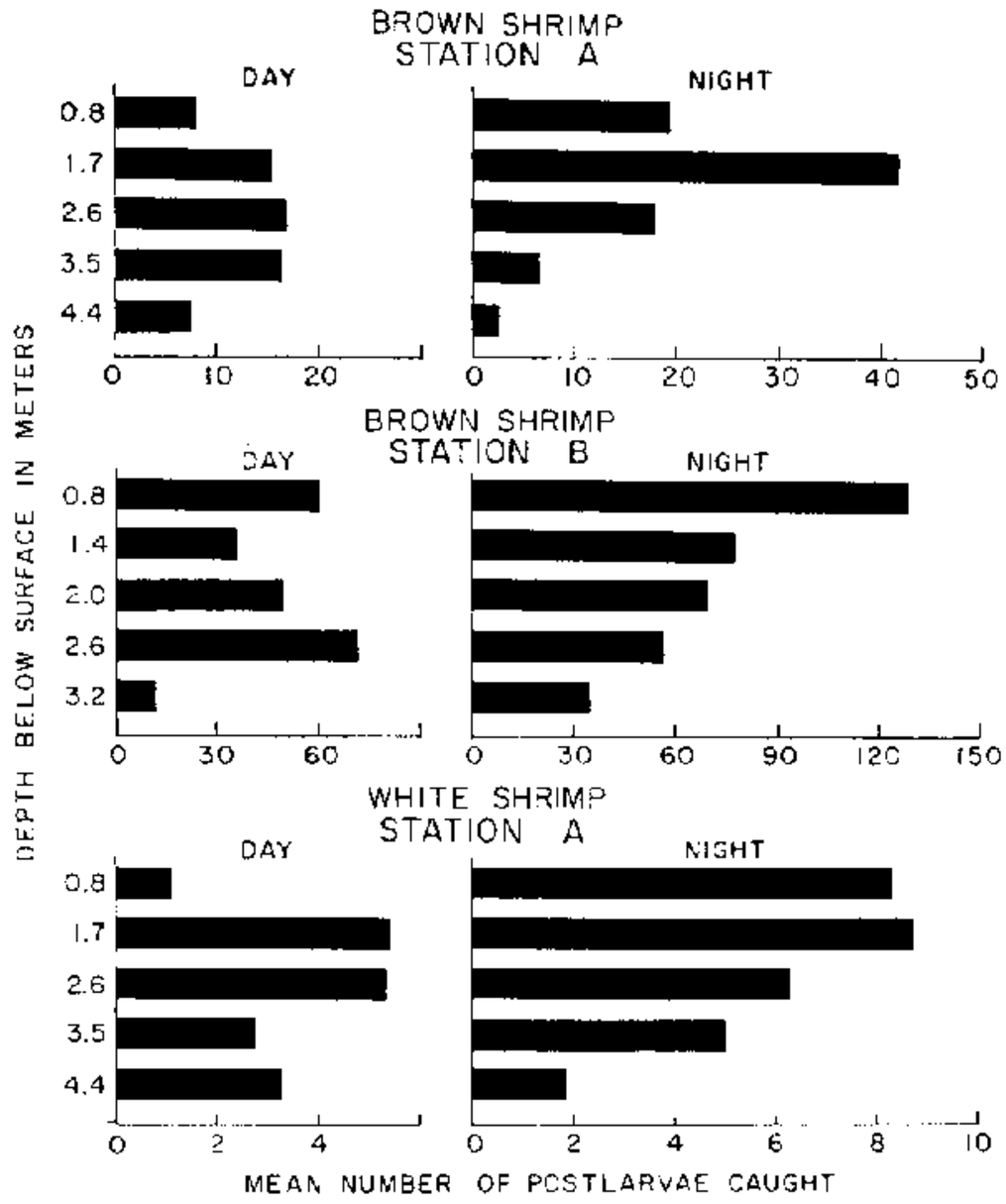

FIGURE 3.—Mean number of postlarval shrimp caught per 100 m³ of water strained in relation to day or night, species, area, and depth.

The number of postlarvae collected at each depth was converted to number of animals caught per 100 m^3 of water strained (Fig. 3), and comparisons of abundance at various depths were made by two-way analysis of variance and Duncan's multiple range test (Steel and Torrie, 1960). All 1-hour sets for the duration of the study were used as replicates for each species, area, and day-night combination. Each set was categorized as either day or night depending on whether the longest duration of fishing was during the day or night. Day was defined as extending from 30 minutes before sunrise to 30 minutes after sunset. It was assumed that there were no seasonal differences in vertical distribution of postlarvae.

VERTICAL DISTRIBUTION

Brown shrimp postlarvae were collected at all depths sampled. During the day, catches were significantly greater at the three middle

TABLE 3.—*Mean number of postlarval shrimp caught per 100 m³ of water strained in relation to day or night, species, area, and depth, and results of two-way analysis of variance comparisons*

Time period	Species	Station	Depth below surface (meters)	Mean number caught per 100 m³ of water strained	Degrees of freedom		Error mean square	F-value
					Treatment	Error		
Day	Brown	A	0.8	7.75	4	152	22.15	2.95*
			1.7	15.36				
			2.6	16.43				
			3.5	16.25				
			4.4	7.46				
		B	0.8	59.46	4	36	344.07	1.23
			1.4	36.71				
			2.0	49.29				
			2.6	70.93				
			3.2	10.50				
	White	A	0.8	1.04	4	56	2.48	1.65
			1.7	5.39				
			2.6	5.36				
			3.5	2.71				
			4.4	3.25				
Night	Brown	A	0.8	19.11	4	72	91.07	3.86**
			1.7	41.54				
			2.6	17.57				
			3.5	6.18				
			4.4	2.14				
		B	0.8	127.11	4	12	383.29	0.95
			1.4	77.61				
			2.0	68.82				
			2.6	56.75				
			3.2	35.39				
	White	A	0.8	8.21	4	64	3.17	3.16*
			1.7	8.64				
			2.6	6.36				
			3.5	4.96				
			4.4	1.89				

* Significant at .05 level.
** Significant at .01 level.

depths at station A than at the shallowest or deepest depth (Table 3). Catches at station B during the day were not significantly different between depths. Differences in vertical distribution between the two locations probably resulted from shallow depths at station B and its location in relation to the sand flat; water appeared more turbulent and moved faster at B than at A (Table 2). During the night, significantly more shrimp were caught at the 1.7-m depth at station A. At station B, night catches were not significantly different between depths even though the surface net produced almost twice as many shrimp as any other depth sampled. The lack of a significant difference was attributed to the small number of samples taken at this station and the variability between individual samples.

White shrimp postlarvae were sampled at station A only and, like browns, were collected at all depths sampled. During the day, catches were highest at the 1.7- and 2.6-m depths but the differences were not significant. At night, postlarvae were significantly more abundant at the surface than at the bottom. Average catch of both species was highest in the upper 2 m of the water column at night and at middepths during the day. One or the other of these depths, depending on whether sampling occurs during the day or night, would probably yield the most accurate abundance estimate, or the greatest catch-per-unit-effort of postlarvae.

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